PATENT ABSTRACTS OF JAPAN

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(71)Applicant : **TOYOTA MOTOR CORP**

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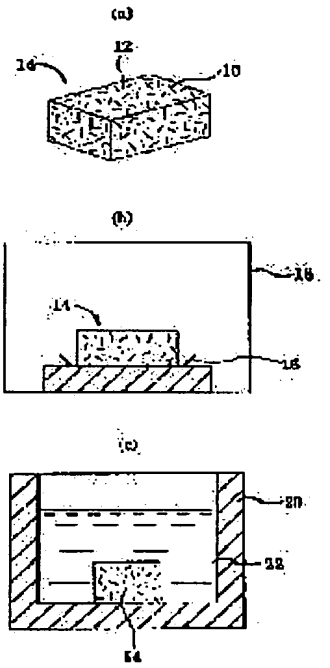
SUGANUMA TETSUYA

(54) METHOD FOR INSERTING METAL BASE COMPOSITE

(57)Abstract:

PURPOSE: To efficiently manufacture a casting inserting the metal base composite into light alloy in good condition at low cost.

CONSTITUTION: This method is the one inserting the metal base composite 14 having pure Al or the light metal mainly containing Al in the matrix 12 in the light alloy and the metal base composite 14 as the material to be inserted is heated at high temp. to melt the matrix 12 and thereafter, the composite is inserted into molten light alloy 22 of Al alloy, etc., containing ≥1wt.% Mg.



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CLAIMS

[Claim(s)]
[Claim 1] The approach which makes it the approach of cast-wrapping the metal matrix composite which is the light metal with which a matrix uses pure aluminum or aluminum as a principal component for a light alloy, is made to carry out melting of the matrix of the surface section of said metal matrix composite at least, and is characterized by cast-wrapping said metal matrix composite in the molten metal of the light alloy containing Mg beyond after an appropriate time 1wt% by heating said metal matrix composite.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an approach to cast-wrap metal matrix composite, and relates to the approach of cast-wrapping the metal matrix composite which makes a light metal a matrix at a detail for a light alloy further.
[0002]
[Description of the Prior Art] aluminum radical composite material which it should cast-wrap is covered with zinc, composite material is arranged to the position in mold, it cast-wraps in mold, teeming of the metaled molten metal is carried out, and the approach of heat-treating the obtained casting is conventionally learned as indicated by JP,60-228964,A as one of the approaches of cast-wrapping the metal matrix composite which makes a light metal a matrix for a light alloy.
[0003] According to this approach to cast-wrap, as compared with the case where it cast-wraps without covering metal matrix composite with zinc, it can cast-wrap, the bonding strength between metals can be raised, and the casting excellent in both integrity for which the composite material which is ******-ed material, and this are cast-wrapped can be manufactured.
[0004]
[Problem(s) to be Solved by the Invention] however, the casting with which it cast-wrapped metal matrix composite in order to precede cast-wrapping in an approach to cast-wrap the conventional metal matrix composite like ****, and to have to cover composite material with zinc, and to cast-wrap and to have to heat-treat a casting behind -- efficiency -- good -- ** -- it is difficult to manufacture cheap.
[0005] the casting with which it cast-wrapped metal matrix composite good in view of the problem like **** in an approach to cast-wrap the above-mentioned conventional metal matrix composite, as for this invention -- efficiency -- good -- ** -- it aims at offering an approach cast-wrapping the metal matrix composite improved so that it can manufacture cheap.
[0006]
[Means for Solving the Problem] The purpose like **** is made into the approach of cast-wrapping the metal matrix composite which is the light metal with which a matrix uses pure aluminum or aluminum as a principal component according to this invention for a light alloy, heats said metal matrix composite, carries out melting of said matrix, and is attained by the approach characterized by cast-wrapping said metal matrix composite in the molten metal of the light alloy containing Mg beyond after an appropriate time 1wt%.
[0007]
[Function] Since melting of the light metal which is the matrix by heating the metal matrix composite which it should cast-wrap is carried out according to the configuration like **** Cast-wrap and cast-wrap with the composite material at the time, and the interface with a metaled molten metal is compared when it is the conventional approach it is the interface of the liquid phase, therefore this interface is a solid-liquid interface. Cast-wrap with the matrix light metal produced in an interface, and counter diffusion of the metallic element between light alloys is performed good far. Moreover, since the oxide formation inclination of Mg is high as compared with other metallic elements like aluminum, it is cast-wrapped and the light alloy contains Mg beyond 1wt% When heated by high temperature, the oxide film of the front face of the composite material with which the matrix light metal is in the melting condition cast-wraps, an oxidation reduction reaction with Mg sometimes breaks, this cast-wraps, and the bonding strength of an interface improves.
[0008] In addition, in the approach of this invention, since the light metal of a melting condition remains between each reinforcement according to the viscosity and the configuration of composite material is held

by reinforcement even if melting of the matrix light metal of the whole composite material is carried out, when metal matrix composite is heated by high temperature, problems, such as superfluous deformation of ******-ed material, do not arise.

[0009]

[Example] This invention is explained to a detail about an example, referring to drawing of attachment in the following.

an example 1 -- 3 micrometers of diameters of average fiber by which orientation was carried out first at random substantially The composite material which makes reinforcement the alumina-silica staple fiber of 3mm of mean fiber length, and makes a matrix pure aluminium (99.9% of purity) is manufactured. By cutting the composite material, the rectangular parallelepiped-like ******-ed material 14 which consists of composite material which makes reinforcement the alumina-silica staple fiber 10 of 30% of rates of the volume, and makes pure aluminium 12 a matrix, and has the dimension of 38x16x10mm was formed as shown in drawing 1 (a).

[0010] Subsequently, by putting the ******-ed material 14 on the tray 16 made from an alumina, and arranging in an electric furnace 18, the whole ******-ed material was heated at about 700 degrees C, and the matrix of the composite material which constitutes ******-ed material by this was fully dissolved as shown in drawing 1 (b).

[0011] Subsequently, the metal mold 20 made of cast iron by which the preheating was carried out to about 300 degrees C whose inner measurements are 30x30x100mm, and whose thickness is 15mm is prepared as shown in drawing 1 (c). The point in contact with ******-ed material arranges it in metal mold 20 on both sides of ******-ed material with the clip made from stainless steel heated by about 700 degrees C. the inside of metal mold -- 750 degrees C -- cast-wrapping -- the aluminium alloy (aluminum-xwt %Mg --) as a light alloy Teeming of the molten metal 22 of x= 0, 0.5, and 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0 was carried out, and even the room temperature was made to cool and solidify a molten metal in the condition as it is.

[0012] Subsequently, it cut and ground so that the composite material which it cast-wrapped in each casting formed in this way could be observed, and the interface between the part of composite material and the part of an aluminium alloy was observed with the optical microscope. The result is shown in the following table 1. In addition, in Table 1, the poor junction section by mediation of the oxide film of aluminum, gas, etc. does not exist in an interface at all, but O shows that good ****** was performed, the poor junction section exists and x shows that good ****** was not performed.

[0013]

[Table 1]

sample No.Mg content (wt%) an interface -- description -- 1 0 x 2 0.5 x 3 1.0 O 4 1.5 O 5 2.0 O 6 3.0 O 7 4.0 O 8 5.0O 96.0 O 10 7.0O 118.0 O 12 9.0O 1310.0 Mg of the matrix of the composite material which constitutes ******-ed material from an O table 1 in order for the poor junction section to perform good ****** which does not exist at all A content is understood that it is desirable that it is more than 1wt%.

[0014] Moreover, drawing 2 is an optical microscope photograph in which the result of SAIPURU No.6 of Table 1 is shown by 1000 times as an example of an interface to which good ****** was performed, and drawing 3 is an optical microscope photograph in which the result of SAIPURU No.1 of Table 1 is shown by 1000 times as an example of an interface to which good ****** was not performed. In addition, in these drawings, a punctate black part is a part of the alumina-silica staple fiber as reinforcement, the parts of white thru/or gray are cast-wrapped, it is the part of a light metal or the aluminium alloy as a matrix, and the black line which extends up and down in the center of drawing 3 shows the interface between the part of composite material, and the part of only an aluminium alloy.

[0015] Moreover, when ****** was performed except for the point that the silicon carbide whisker (the Tokai Carbon Co., Ltd. make, 0.3 micrometers of diameters of average fiber, 100 micrometers of mean fiber length) of 25% of rates of the volume by which orientation was substantially carried out at random as reinforcement was used, on the same point and the same conditions as a case of the above-mentioned example 1, the same result as the case of an example 1 was obtained.

The alumina particle (the Showa Denko K.K. make and mean particle diameter of 3 micrometers) of 50% of two examples moments is made into reinforcement. The composite material which makes an aluminium alloy (JIS 2024) a matrix is manufactured. 38x16x20mm ******-ed material is started from the composite material. The point which cast-wrapped the molten metal of a 780-degree C aluminium alloy (JIS AC4C) and the molten metal of an aluminium alloy (JIS AC4C corrected so that Mg content might become high only 1wt%), and was used as a molten metal of an alloy is removed. ****** was performed on the same

point and the same conditions as a case of the above-mentioned example 1, it cast-wrapped in the same way as the case of an example 1, and the interface was observed with the optical microscope.
[0016] When the aluminium alloy with which Mg content increased was used to having cast-wrapped and the poor junction section having existed in the interface, when the molten metal of the aluminium alloy of JIS AC4C was used as it was as a result, it was admitted that it cast-wraps, and the poor junction section by mediation of an oxide film, gas, etc. did not exist in an interface at all, but it cast-wrapped composite material good in an aluminium alloy.
[0017] moreover -- as the reinforcement of the composite material which it should cast-wrap -- the silicon carbide particle (the Showa Denko K.K. make --) of 50% of rates of the volume Mean particle diameter of 20 micrometers When used, and also when the alumina staple fiber (the product "SAFIRU RF" made from British ICI, mean particle diameter of 3 micrometers, and 3mm of mean fiber length) of 25% of rates of the volume by which orientation was carried out substantially at random was used, the good result as well as the case of the above-mentioned example 2 was obtained.
[0018] In addition, good ****** was able to be carried out for ****** to neither of the cases with **** at the time, without heating the composite material which it should cast-wrap in each above-mentioned example with an electric furnace for the comparative purpose.
[0019] Although this invention was explained to the detail about the specific example above, probably this invention will not be limited to these examples and it will be clear for this contractor its for other various examples to be possible within the limits of this invention.
[0020] For example, although melting of the matrix of the whole metal matrix composite was completely carried out in the above-mentioned example, melting only of the matrix of the surface section of composite material may be carried out, and it can cast-wrap composite material good in a light alloy also in such a case.
[0021]
[Effect of the Invention] According to this invention, cast-wrap and cast-wrap with the composite material at the time, and when it is the conventional approach the interface with a metaled molten metal is an interface of the liquid phase, therefore this interface is a solid-liquid interface, it compares, so that more clearly than the above explanation. It can cast-wrap with the matrix light metal produced in an interface, and the counter diffusion of the metallic element between light alloys can be made to perform good far. Moreover, since it cast-wraps, and the light alloy contains Mg beyond 1wt%, the oxide film of the front face of the composite material with which the matrix light metal is in the melting condition when heated by high temperature cast-wraps and an oxidation reduction reaction with Mg sometimes breaks It cast-wraps, and the bonding strength of an interface can be raised and the metal matrix composite which is the light metal with which a matrix uses pure aluminum or aluminum as a principal component can be cast-wrapped good.
[0022] moreover, the casting with which it cast-wrapped metal matrix composite good as compared with the case of the above-mentioned conventional approach since according to this invention the metal matrix composite which it should cast-wrap did not need to be covered with zinc, or it cast-wrapped and a casting did not need to be heat-treated after completion -- efficiency -- good -- ** -- it can manufacture cheap.

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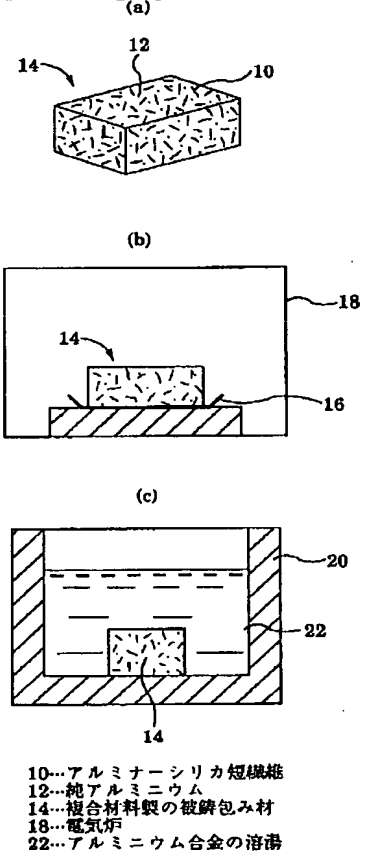
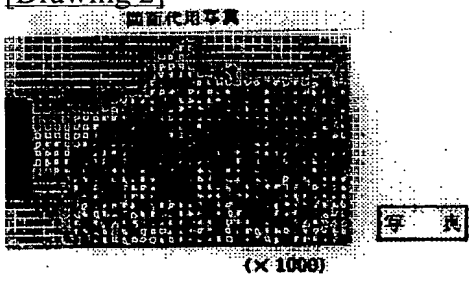
DRAWINGS

[Drawing 1]

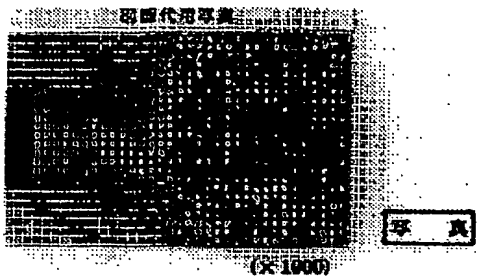


10…アルミナーシリカ短繊維
12…純アルミニウム
14…複合材料製の被覆包み材
18…電気炉
22…アルミニウム合金の溶湯

[Drawing 2]



[Drawing 3]



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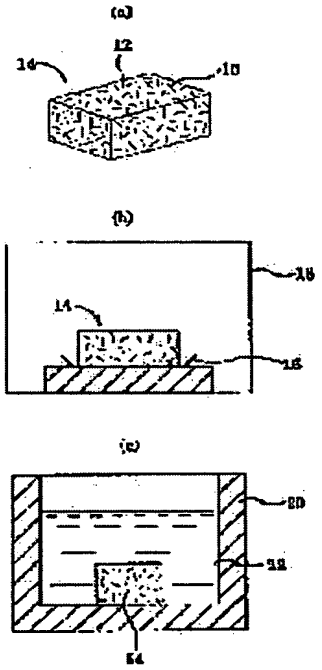

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Ｃ２２Ｃ	1/09	Ｚ			
	1/10	Ｚ			

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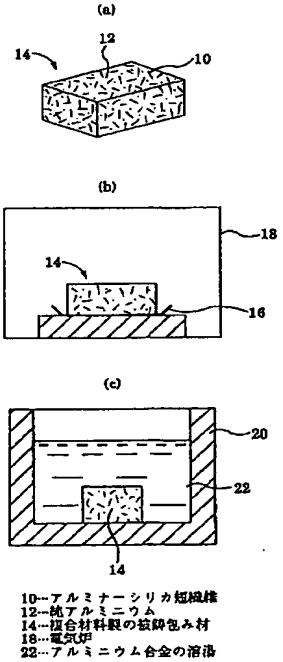
(54)【発明の名称】　金属基複合材料の鋳包み方法

(57)【要約】

【目的】　金属基複合材料が軽合金中に良好に鋳包まれた鋳物を能率よく且低廉に製造する。

【構成】　マトリックス１２が純Ａｌ又はＡｌを主成分とする軽金属である金属基複合材料１４を軽合金に鋳包む方法であり、被鋳包み材としての金属基複合材料１４を高温度に加熱してマトリックス１２を溶融させ、しかる後１wt%以上のＭｇを含有するＡｌ合金などの軽合金の溶湯２２中に複合材料を鋳包むことを特徴とする。



10…アルミナーシリカ短繊維
12…純アルミニウム
14…複合材料製の被鋳包み材
18…電気炉
22…アルミニウム合金の溶湯

1

【特許請求の範囲】

【請求項１】マトリックスが純Ａｌ又はＡｌを主成分とする軽金属である金属基複合材料を軽合金に鋳包む方法にして、前記金属基複合材料を加熱することにより少なくとも前記金属基複合材料の表面部のマトリックスを溶融させ、しかる後１wt%以上のＭｇを含有する軽合金の溶湯中に前記金属基複合材料を鋳包むことを特徴とする方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、金属基複合材料の鋳包み方法に係り、更に詳細には軽金属をマトリックスとする金属基複合材料を軽合金に鋳包む方法に係る。

【０００２】

【従来の技術】軽金属をマトリックスとする金属基複合材料を軽合金に鋳包む方法の一つとして、例えば特開昭６０－２２８９６４号公報に記載されている如く、鋳包まれるべきＡｌ基複合材料を亜鉛にて被覆し、複合材料を鋳型内の所定の位置に配置して鋳型内に鋳包み金属の溶湯を注湯し、得られた鋳物を熱処理する方法が従来より知られている。

【０００３】かかる鋳包み方法によれば、金属基複合材料が亜鉛にて被覆されることなく鋳包まれる場合に比して、被鋳包み材である複合材料とこれを鋳包む鋳包み金属との間の接合強度を向上させることができ、両者の一体性に優れた鋳物を製造することができる。

【０００４】

【発明が解決しようとする課題】しかし上述の如き従来の金属基複合材料の鋳包み方法に於ては、鋳包みに先立ち複合材料を亜鉛にて被覆しなければならず、また鋳包み後に鋳物を熱処理しなければならないため、金属基複合材料が鋳包まれた鋳物を能率よく且低廉に製造することが困難である。

【０００５】本発明は、上述の従来の金属基複合材料の鋳包み方法に於ける上述の如き問題に鑑み、金属基複合材料が良好に鋳包まれた鋳物を能率よく且低廉に製造することができるよう改善された金属基複合材料の鋳包み方法を提供することを目的としている。

【０００６】

【課題を解決するための手段】上述の如き目的は、本発明によれば、マトリックスが純Ａｌ又はＡｌを主成分とする軽金属である金属基複合材料を軽合金に鋳包む方法にして、前記金属基複合材料を加熱して前記マトリックスを溶融させ、しかる後１wt%以上のＭｇを含有する軽合金の溶湯中に前記金属基複合材料を鋳包むことを特徴とする方法によって達成される。

【０００７】

【作用】上述の如き構成によれば、鋳包まれるべき金属基複合材料が加熱されることによりそのマトリックスである軽金属が溶融されるので、鋳包み時に於ける複合材料と鋳包み金属の溶湯との界面は液相同士の界面であり、従ってかかる界面が固液界面である従来の方法の場合に比して、界面に於て生じるマトリックス軽金属と鋳包み軽合金との間の金属元素の相互拡散が遥かに良好に行われ、またＭｇはＡｌの如き他の金属元素に比して酸化物形成傾向が高く、鋳包み軽合金は１wt%以上のＭｇを含有しているので、高温度に加熱されることによりマトリックス軽金属が溶融状態になっている複合材料の表面の酸化膜が鋳包み時にＭｇとの酸化還元反応により破壊され、これにより鋳包み界面の接合強度が向上される。

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【０００８】尚本発明の方法に於ては、金属基複合材料が高温度に加熱されることにより複合材料全体のマトリックス軽金属が溶融されても、溶融状態の軽金属はその粘性により個々の強化材の間に止どまり、強化材により複合材料の形状は保持されるので、被鋳包み材の過剰の変形などの問題が生じることはない。

【０００９】

【実施例】以下に添付の図を参照しつつ、本発明を実施例について詳細に説明する。

実施例１

まず実質的に無作為に配向された平均繊維径３μm、平均繊維長３mmのアルミナ－シリカ短繊維を強化材とし純アルミニウム（純度９９．９%）をマトリックスとする複合材料を製造し、その複合材料を切断することにより、図１（ａ）に示されている如く、体積率３０%のアルミナ－シリカ短繊維１０を強化材とし純アルミニウム１２をマトリックスとする複合材料よりなり３８×１６×１０mmの寸法を有する直方体状の被鋳包み材１４を形成した。

【００１０】次いで図１（ｂ）に示されている如く、被鋳包み材１４をアルミナ製のトレー１６に載せて電気炉１８内に配置することにより被鋳包み材全体を約７００℃に加熱し、これにより被鋳包み材を構成する複合材料のマトリックスを十分に溶解した。

【００１１】次いで図１（ｃ）に示されている如く、内のり寸法が３０×３０×１００mmであり肉厚が１５mmである約３００℃に予熱された鋳鉄製の金型２０を用意し、被鋳包み材に接触する先端部が約７００℃に加熱されたステンレス鋼製の挟みにて被鋳包み材を挟んでそれを金型２０内に配置し、金型内に７５０℃の鋳包み軽合金としてのアルミニウム合金（Ａｌ－ｘwt%Ｍｇ、ｘ＝０、０．５、１．０、１．５、２．０、３．０、４．０、５．０、６．０、７．０、８．０、９．０、１０．０）の溶湯２２を注湯し、そのままの状態にて溶湯を室温にまで冷却し凝固させた。

【００１２】次いでかくして形成された各鋳物をそれに鋳包まれた複合材料を観察し得るよう切断して研磨し、複合材料の部分とアルミニウム合金の部分との間の界面を光学顕微鏡にて観察した。その結果を下記の表１に示

す。尚表１に於て、○は界面にＡｌの酸化膜やガス等の介在による接合不良部が全く存在せず良好な鋳包みが行われていたことを示しており、×は接合不良部が存在し＊良好な鋳包みが行われていなかったことを示している。

【００１３】

【表１】

サンプルＮｏ．	Ｍｇ含有量（wt%）	界面性状
1	0	×
2	0．5	×
3	1．0	○
4	1．5	○
5	2．0	○
6	3．0	○
7	4．0	○
8	5．0	○
9	6．0	○
10	7．0	○
11	8．0	○
12	9．0	○
13	10．0	○

表１より、接合不良部が全く存在しない良好な鋳包みを行うためには、被鋳包み材を構成する複合材料のマトリックスのMg 含有量は１wt%以上であることが好ましいことが解る。

【００１４】また図２は良好な鋳包みが行われた界面の一例として表１のサイプルＮｏ．６の結果を１０００倍にて示す光学顕微鏡写真であり、図３は良好な鋳包みが行われなかった界面の一例として表１のサイプルＮｏ．１の結果を１０００倍にて示す光学顕微鏡写真である。尚これらの図に於て、黒色の斑点状の部分は強化材としてのアルミナーシリカ短繊維の部分であり、白色乃至灰色の部分は鋳包み軽金属又はマトリックスとしてのアルミニウム合金の部分であり、図３の中央にて上下に延在する黒色の線は複合材料の部分とアルミニウム合金のみの部分との間の界面を示している。

【００１５】また強化材として実質的に無作為に配向された体積率２５%の炭化ケイ素ウイスカ（東海カーボン株式会社製、平均繊維径０．３μｍ、平均繊維長１００μｍ）が使用された点を除き上述の実施例１の場合と同一の要領及び条件にて鋳包みを行ったところ、実施例１の場合と同様の結果が得られた。

実施例２

体積率５０%のアルミナ粒子（昭和電工株式会社製、平均粒径３μｍ）を強化材とし、アルミニウム合金（ＪＩＳ規格２０２４）をマトリックスとする複合材料を製造し、その複合材料より３８×１６×２０㎜の被鋳包み材を切出し、７８０℃のアルミニウム合金（ＪＩＳ規格ＡＣ４Ｃ）の溶湯及びアルミニウム合金（Ｍｇ含有量が１wt%だけ高くなるよう修正されたＪＩＳ規格ＡＣ４Ｃ）の溶湯を鋳包み合金の溶湯として使用した点を除き、上述の実施例１の場合と同一の要領及び条件にて鋳包みを行い、実施例１の場合と同一の要領にて鋳包み界面を光学顕微鏡にて観察した。

【００１６】その結果ＪＩＳ規格ＡＣ４Ｃのアルミニウム合金の溶湯がそのまま使用された場合には鋳包み界面に接合不良部が存在していたのに対し、Ｍｇ含有量が増大されたアルミニウム合金が使用された場合には鋳包み界面に酸化膜やガス等の介在による接合不良部は全く存在せず、複合材料がアルミニウム合金中に良好に鋳包まれていることが認められた。

【００１７】また鋳包まれるべき複合材料の強化材として体積率５０%の炭化ケイ素粒子（昭和電工株式会社製、平均粒径２０μｍ）が使用された場合、及び実質的に無作為に配向された体積率２５%のアルミナ短繊維（英国ＩＣＩ社製「サフィールＲＦ」、平均粒径３μｍ、平均繊維長３㎜）が使用された場合にも上述の実施例２の場合と同様に良好な結果が得られた。

【００１８】尚比較の目的で、上述の各実施例に於て鋳包まれるべき複合材料を電気炉により加熱することなく鋳包みを試たところ、何れの場合にも良好な鋳包みを行うことはできなかった。

【００１９】以上に於ては本発明を特定の実施例について詳細に説明したが、本発明はこれらの実施例に限定されるものではなく、本発明の範囲内にて他の種々の実施例が可能であることは当業者にとって明らかであろう。

【００２０】例えば上述の実施例に於ては金属基複合材料全体のマトリックスが完全に溶融されたが、複合材料の表面部のマトリックスのみが溶融されてもよく、その場合にも複合材料を軽合金中に良好に鋳包むことができる。

【００２１】

【発明の効果】以上の説明より明らかである如く、本発明によれば、鋳包み時に於ける複合材料と鋳包み金属の溶湯との界面は液相同士の界面であり、従ってかかる界面が固液界面である従来の方法の場合に比して、界面に於て生じるマトリックス軽金属と鋳包み軽合金との間の

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金属元素の相互拡散を遥かに良好に行わせることができ、また鋳包み軽合金は１wt%以上のＭｇを含有しており、高温度に加熱されることによりマトリックス軽金属が溶融状態になっている複合材料の表面の酸化膜が鋳包み時にＭｇとの酸化還元反応により破壊されるので、鋳包み界面の接合強度を向上させ、マトリックスが純Ａｌ又はＡｌを主成分とする軽金属である金属基複合材料を良好に鋳包むことができる。

【００２２】また本発明によれば、鋳包まれるべき金属基複合材料を亜鉛にて被覆したり、鋳包み完了後に鋳物を熱処理したりする必要がないので、前述の従来の方法の場合に比して金属基複合材料が良好に鋳包まれた鋳物を能率よく且低廉に製造することができる。

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＊【図面の簡単な説明】

【図１】本発明による金属基複合材料の鋳包み方法の一つの実施例の一連の工程を示す工程図である。

【図２】良好な鋳包みが行われた鋳物の界面近傍の断面を１０００倍にて示す光学顕微鏡写真である。

【図３】良好な鋳包みが行われなかった鋳物の界面近傍の断面を１０００倍にて示す光学顕微鏡写真である。

【符号の説明】

１０…アルミナーシリカ短繊維

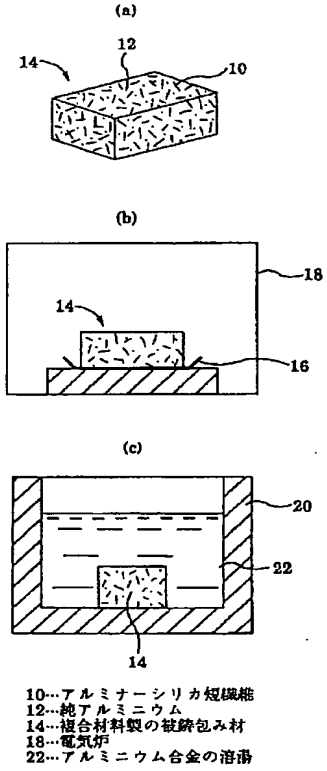
１２…純アルミニウム

１４…複合材料製の被鋳ぐるみ材

１８…電気炉

２２…アルミニウム合金の溶湯

【図１】



【図２】

【図３】